

CloudSat:

*Science, Mission, and
Educational Outreach*



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Overview

CloudSat - what it is, what it does, why it matters

The CloudSat Education Network (CEN) - Student-based observation network as part of outreach

Development of State/National-Standard based projects using CloudSat, GLOBE, and CEN observations for science exploration



What is CloudSat?

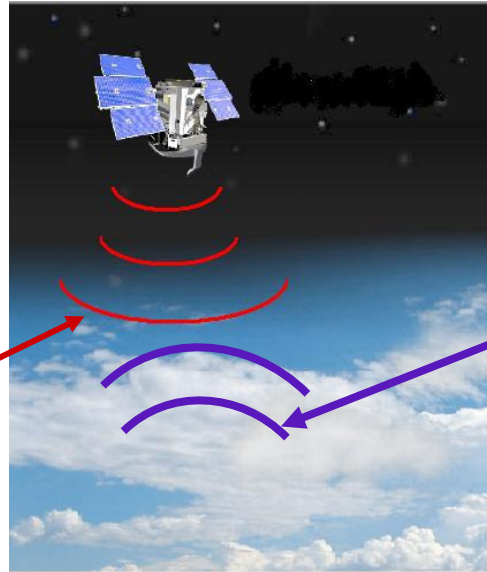


- Space-based cloud radar
- Designed to see cloud droplets (as opposed to rain)
- Orbiting in formation with several other different satellites (the 'A-Train')
- 98-minute orbital period, repeats every 10-16 days
- Crosses the equator around 1:00pm local solar time each day
- Launched 28 April 2006 from Vandenberg AFB, California



How the CloudSat Radar Works

As CloudSat orbits Earth, it transmits short pulses of microwave energy down into the Earth's atmosphere.



The CloudSat radar measures the time delay and magnitude of the reflected signal



*A fraction of these pulses reflect off of cloud particles and bounce back to the satellite.
Other pulses continue downward*

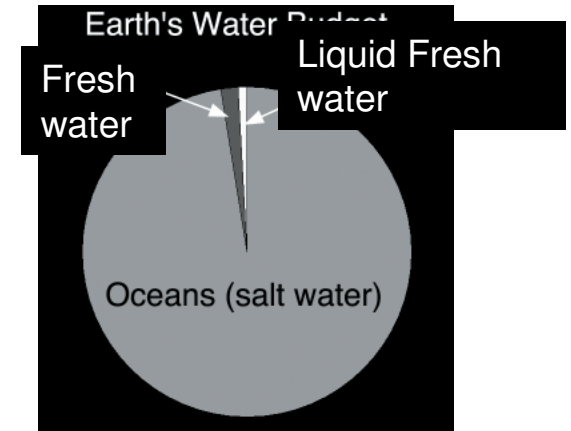


JPL

**Colorado
State
University**

Why CloudSat?

Clouds are the ultimate source of the planet's fresh water supply



Clouds produce energy that fuel weather and storms



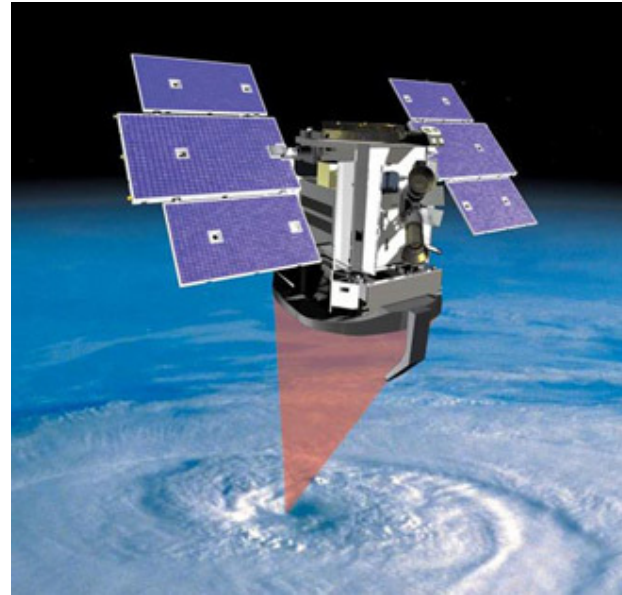
Clouds affect the energy that flows in and out of Earth, shaping our climate



Outreach component: the CloudSat Education Network

The CloudSat Education Network (CEN) is an international network of schools making surface observations (based on the GLOBE Atmosphere protocol) to compare with CloudSat radar data.

Students are GLOBE-trained and take both GLOBE and CEN observations, which are then reported via the CEN website (and forwarded to GLOBE)



Observations are timed to coincide with overpasses of CloudSat - happens every 10-16 days for any single school

Observations include measurement of temperature, cloud type and cover, contrail information, and precipitation, along with cloud photos!



A day in the life of a CEN School

Schools log in from the CloudSat webpage using their GLOBE ID and the CEN password assigned to them

The first page they see is the index page, which contains links to: the data entry page, the CloudSat overpass predictor tool, and data and photo retrieval pages

First, we want to find when CloudSat will be overhead...



The screenshot shows the CloudSat Education Network homepage. At the top is a banner with a satellite image and the text "CloudSat Education Network". Below the banner is a navigation bar with "CloudSat Education Network: Home (Logout)". A welcome message follows: "Welcome to the CloudSat Education Network, Stephens Research Group/JPL (Dev Team)". The main content area features a satellite image on the left and text on the right stating: "This is your portal page to the CloudSat Education network - here you will find links to our Data Entry page, our satellite overpass predictor for your school, as well as forms and updates that you'll find useful as you and your students help participate in the CloudSat mission!". Below this, it says: "As of our latest update, photo submission is working - you may now submit photos on the data entry page, and view them using the photo viewing link below!". The page is divided into two columns. The left column is titled "Data Entry Tools" and contains links for "CEN Data Entry Page", "CloudSat Overpass Predictor", "CEN Data Retrieval NEW!!", and "CEN Photo Viewer NEW!!". The right column is titled "CEN Documentation" and contains a list of links including "CloudSat Total Sky Imaging Protocol Field Guide NEW!!", "CloudSat Total Sky Imaging Protocol Instructions NEW!!", "CEN 1-day data sheets", "CEN Multi day data sheets", "CEN special protocol quadrant instructions", and "CEN special protocol precipitation".

CloudSat Education Network

CloudSat Education Network: Home ([Logout](#))

Welcome to the **CloudSat Education Network**, Stephens Research Group/JPL (Dev Team)

This is your portal page to the CloudSat Education network - here you will find links to our Data Entry page, our satellite overpass predictor for your school, as well as forms and updates that you'll find useful as you and your students help participate in the CloudSat mission!

As of our latest update, photo submission is working - you may now submit photos on the data entry page, and view them using the photo viewing link below!

Data Entry Tools

The following links are tools for entering your CEN data, or finding when CloudSat will be overhead.


- [CEN Data Entry Page](#) - click to enter your CloudSat observations and photos
- [CloudSat Overpass Predictor](#) click to find dates and times when CloudSat will be over your school
- [CEN Data Retrieval NEW!!](#) Click to see your observations in the CEN database!
- [CEN Photo Viewer NEW!!](#) Click to view the photos you've submitted to CEN!

CEN Documentation

These links lead to forms and instruction sheets that you'll reference as you perform your research.

- [CloudSat Total Sky Imaging Protocol Field Guide NEW!!](#) - CEN sky imaging protocol field guide
- [CloudSat Total Sky Imaging Protocol Instructions NEW!!](#) - CEN sky imaging protocol instructions
- [CEN 1-day data sheets](#) - data sheet to enter in 1 days worth of data
- [CEN Multi day data sheets](#) - data sheets to enter multiple days of data
- [CEN special protocol quadrant instructions](#)
- [CEN special protocol precipitation](#)





CloudSat Education Network

CloudSat Education Network: CloudSat Overpass Finder Results ([Logout](#))

Welcome to the **CloudSat Education Network, Stephens Research Group/JPL (Dev Team)**

CloudSat overpasses for Stephens Research Group/JPL (Dev Team) for the two-week period starting on 03/05/2007 21:44:36 UTC:

Overpass on 03/13/2007 20:14:00 UTC

[Return](#) to Index page

Contact the CloudSat Outreach team: cloudsatoutreach.colostate.edu
Last Update: 28 August 2006

...using the overpass predictor, we find out when CloudSat will be over our school.

On that date and time, we go out and take our measurements!





Once our data is collected, we go back to the webpage, and use the data entry page to submit our observations and photos.

Data is sent to CEN and to GLOBE as well - no need to enter your GLOBE Atmosphere observations twice!

Data is stored locally, as well as on the GLOBE homepage.



CloudSat Education Network

CloudSat Education Network: Data Entry ([Logout](#))

Welcome to the **CloudSat Education Network** data entry page, **Stephens Research Group/JPL (Dev Team)**

Observer Data

Enter in the observer's name, the study site used to make the observations, and the time the observations were made, which should be as close to CloudSat flyby as possible.

Observer name:

Study Site: ATM-01 (ACRC Building)

Year: 2007 Month: January Day: Hour: : Minute: [UTC](#)

Temperature

Enter the observed temperature at flyover here:

Temperature: degrees C

What type of thermometer was used?

Thermometer Type: Digital Max/Min

Cloud Observations: Whole-Sky

All-Sky Observations

Enter the total amount of cloud cover here:

No Clouds (0%)

Check the boxes for each type of cloud observed:

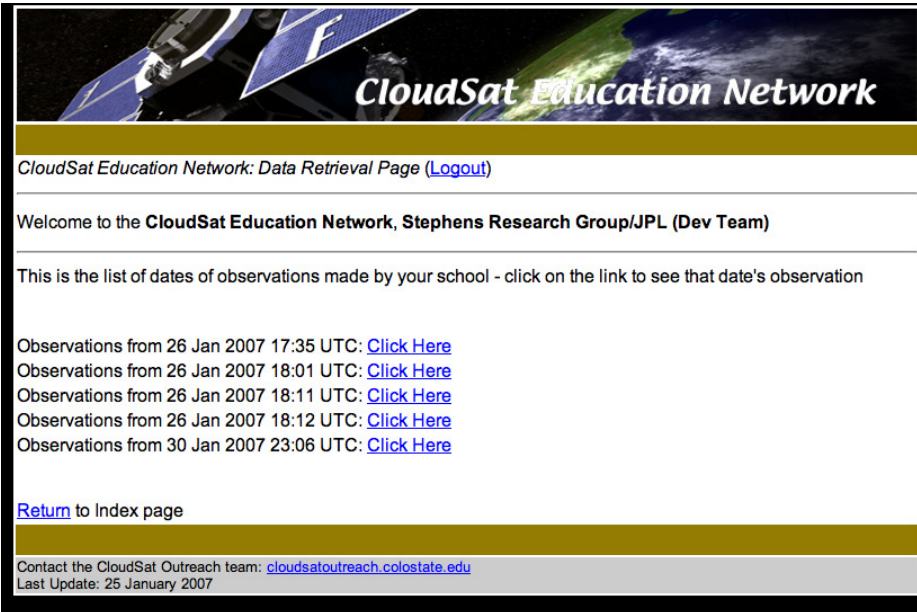
<input type="checkbox"/> Cirrostratus	<input type="checkbox"/> Cirrus	<input type="checkbox"/> Cirrocumulus
<input type="checkbox"/> Altostratus	<input type="checkbox"/> Stratocumulus	<input type="checkbox"/> Altocumulus
<input type="checkbox"/> Stratus	<input type="checkbox"/> Cumulus	<input type="checkbox"/> Cumulonimbus
<input type="checkbox"/> Nimbostratus		

Contrails

Contrail Type: (enter the number of each type observed)

CEN Data Retrieval

Students can look at their text observations...



CloudSat Education Network

CloudSat Education Network: Data Retrieval Page ([Logout](#))

Welcome to the **CloudSat Education Network, Stephens Research Group/JPL (Dev Team)**

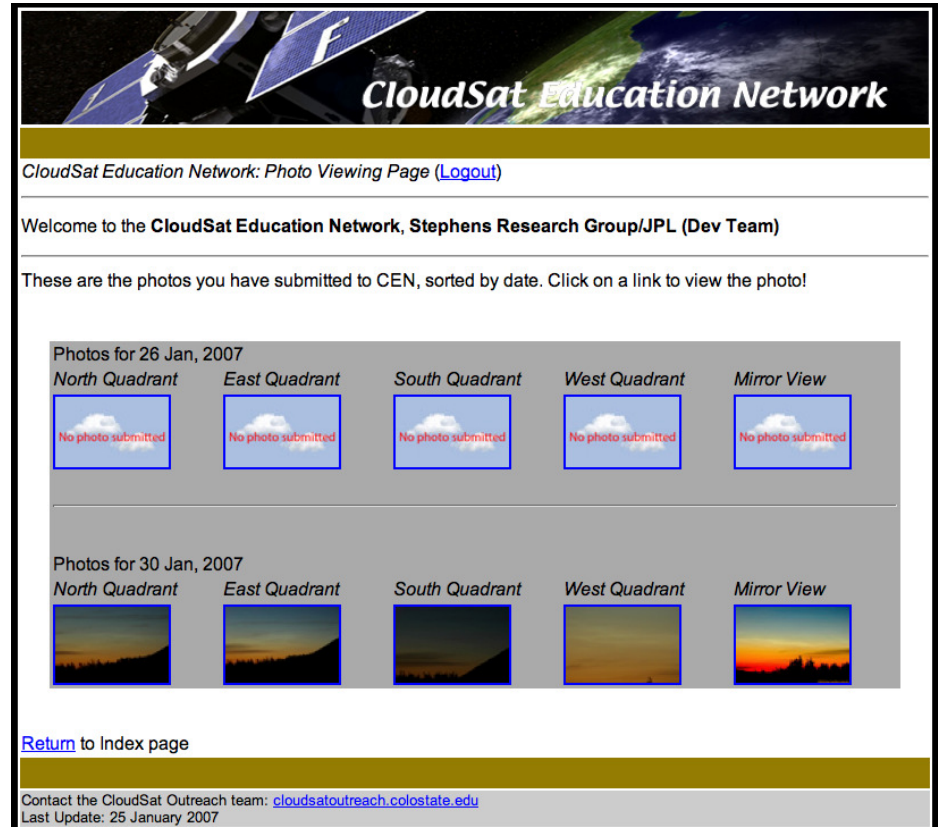
This is the list of dates of observations made by your school - click on the link to see that date's observation

Observations from 26 Jan 2007 17:35 UTC: [Click Here](#)
Observations from 26 Jan 2007 18:01 UTC: [Click Here](#)
Observations from 26 Jan 2007 18:11 UTC: [Click Here](#)
Observations from 26 Jan 2007 18:12 UTC: [Click Here](#)
Observations from 30 Jan 2007 23:06 UTC: [Click Here](#)

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Last Update: 25 January 2007

...or look at the photos they submitted!








CloudSat Education Network

CloudSat Education Network: Photo Viewing Page ([Logout](#))






Welcome to the **CloudSat Education Network, Stephens Research Group/JPL (Dev Team)**

These are the photos you have submitted to CEN, sorted by date. Click on a link to view the photo!

Photos for 26 Jan, 2007

North Quadrant	East Quadrant	South Quadrant	West Quadrant	Mirror View
				

Photos for 30 Jan, 2007

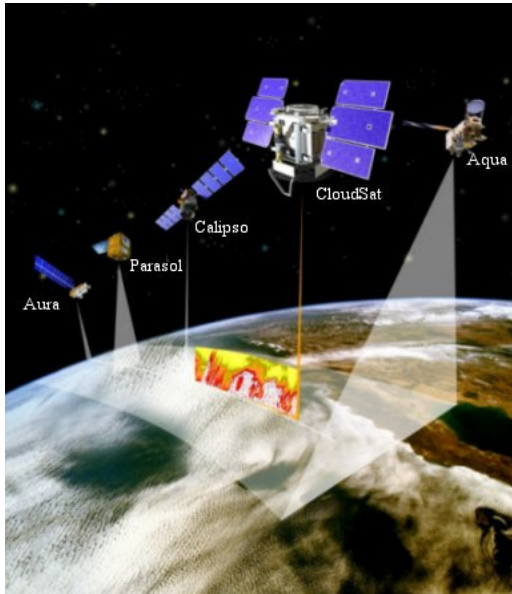
North Quadrant	East Quadrant	South Quadrant	West Quadrant	Mirror View
				

[Return](#) to Index page

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Last Update: 25 January 2007



Using the data in state standards-based research projects



Student observations useful on several levels - goal is to use observations in meaning research

Teachers constrained to set curriculum based on science standards - little 'wiggle room' in what can be taught and when

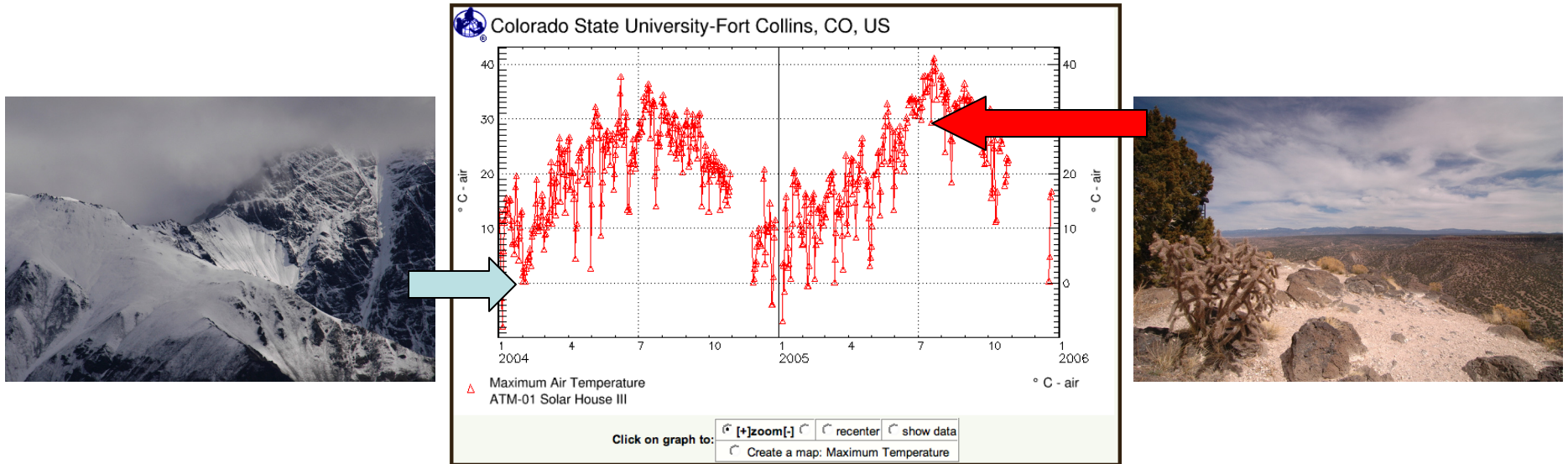
Solution: Use CloudSat, GLOBE, and CEN observations to answer the scientific questions that *are* posed in state standards

Develop ready-to-go projects, based off of science standards for different grade levels, where students help answer some of the same scientific questions that CloudSat researchers are looking at

Make scientists and staff available for development of new projects



Elementary School - Identify clouds, identify seasons



Based on NSES K-4 Earth and Space Science Content Standard

Students record GLOBE Atmosphere observations along with CEN cloud type observations over the year - observe how clouds change as the seasons change

Inquiry - why is this so? Are there links between GLOBE observations (temperature, humidity, etc.) and the types of clouds you see?

Emphasis: developing observation and description skills

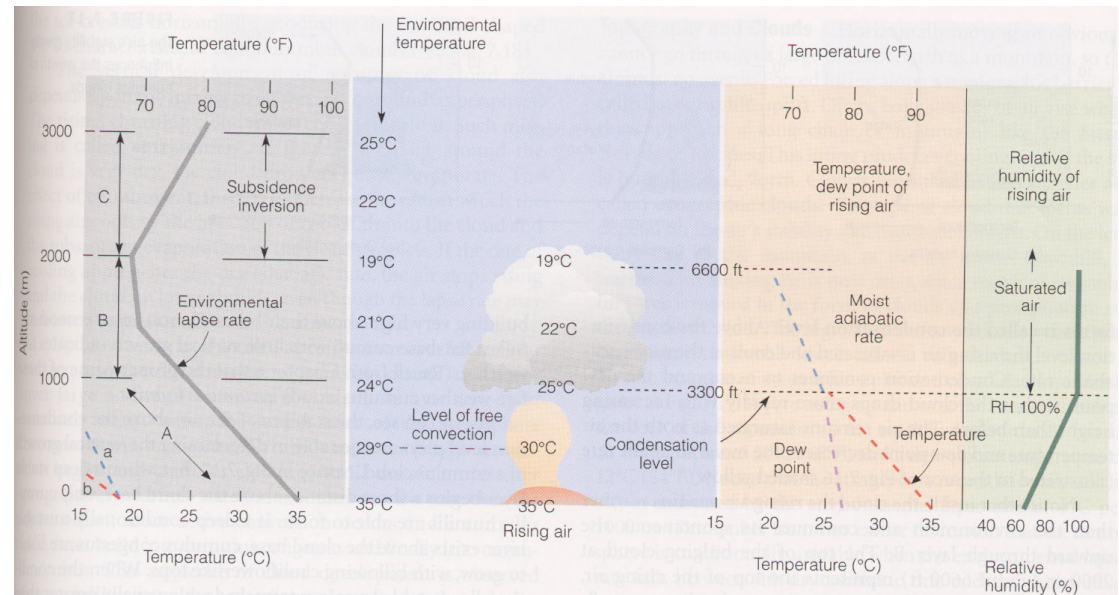


High School - Explore the thermodynamic properties of clouds

Basis: Physical, Space and Earth Science Content Standards in NSES (standards B and D, respectively)

Topics touched on: conservation of energy, latent heat of condensation, buoyancy of fluids

Emphasis on investigating the state of the natural world based on observations



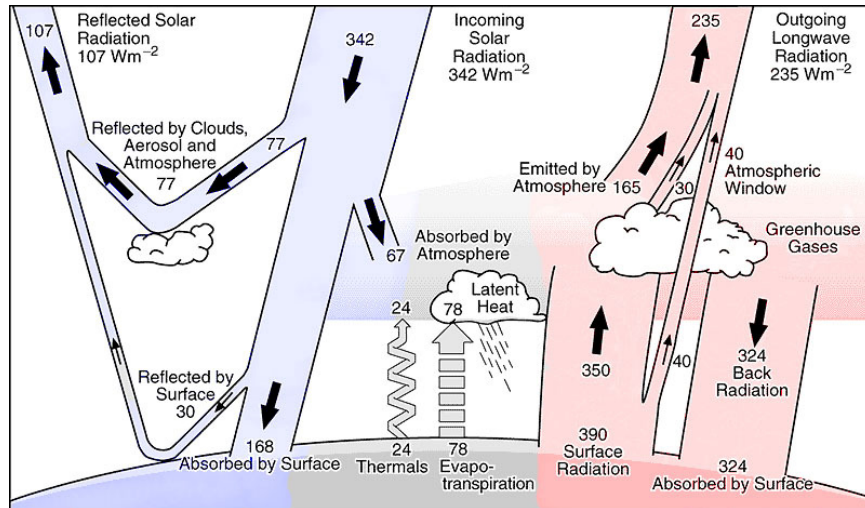
Project integrated into earth science curricula dealing with standards - additional unit on cloud formation based on standards available

Students take cloud observations and use knowledge of cloud formation mechanisms to assess environmental conditions (instability, lifting of airmasses, etc.)

Learn to identify environmental conditions that favor certain cloud types



High School - Explore the thermodynamic properties of clouds



Scientific Inquiries:

Climate change: understanding environmental influences on cloud formation, combined with knowledge of how clouds in turn influence the environment

Severe Weather: what are the conditions that favor flooding, damaging hail and winds, or tornadoes? What are the optimal environmental conditions for hurricanes?

Develop links between science content taught in the standards and these (and other) inquiries

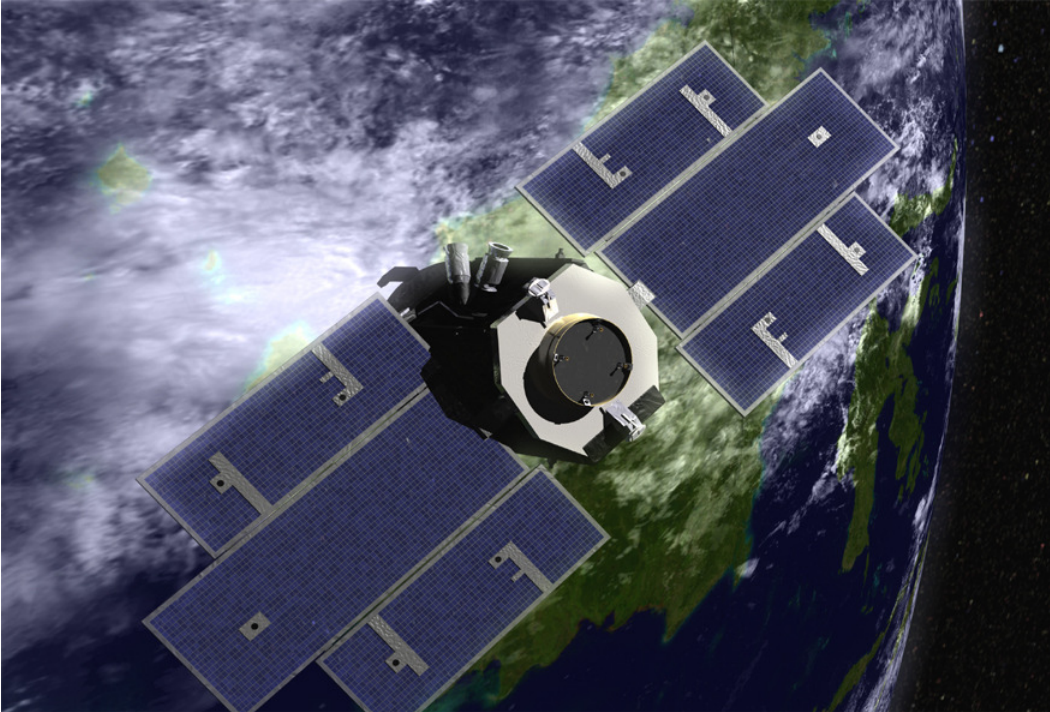


Development Outline

- 1.) Identify key standards to be addressed
- 2.) Pose scientific question (that can be investigated using GLOBE and CEN observations - that's where we come in)
- 3.) Have students develop hypothesis relating to scientific questions, identify observations needed to test hypothesis
- 4.) Identify materials needed, timeline of project
- 5.) Make observations as necessary, analyze results
- 6.) Scientific results and feedback with scientists involved - potential for discoveries are found here!



Where we are, where we're going



Intro projects developed for K-5 and high school level, currently developing middle school project

Road-test of projects with interested CEN teachers - initial projects to be tested and refined during 2007-2008 school year

Feedback from teachers, scientists, and GLOBE on results will dictate future projects and the direction they take

By end of mission, we'll have developed several observation-based projects for exploration of the governing principals of the environment, using CloudSat and GLOBE observations

We'd like to hear from you!

